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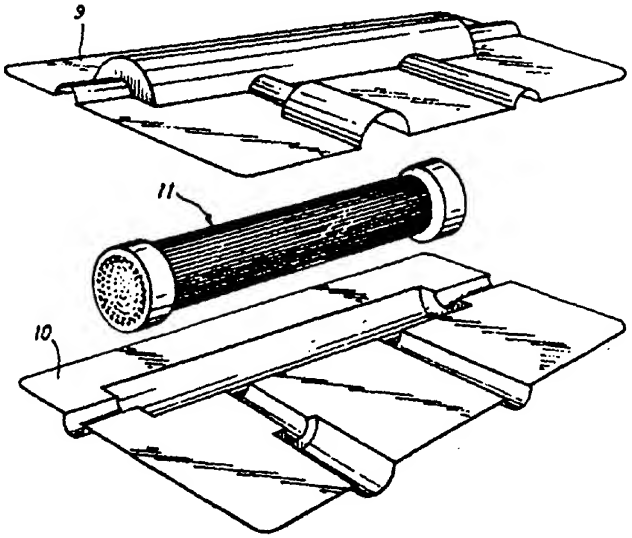
(54) Title: MEMBRANE FILTER UNIT AND PROCESS OF PRODUCING SAID UNIT



(57) Abstract

There is described a membrane unit wherein at least two outer casing portions are sealed together around a membrane. The unit is desirably formed from a process whereby the two outer casing portions are provided, a membrane is located within the casing and said casing portions are sealed together, advantageously with a blue light or UV light curing adhesive. The membrane may be in the form of hollow fibre(s) and a preliminary step involving the formation of a plug of adhesive around the fibre may be present in the process. The set plug of adhesive may be trimmed and then placed into the outer casing portions for sealing therein.

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"Membrane Filter Unit and Process of Producing said Unit"

The present invention is concerned with a process for producing sealed units which comprise a membrane barrier and the units produced by that process.

Sealed membrane units are desirable for many purposes which require a filtration step. Generally, the membrane is sealed into the unit in such a way that the mother liquor (liquid to be processed) is separated from the filtrate by the membrane. Where the membrane unit is to be used for medical purposes for example dialysis, it is of course particularly important for the unit to be sealed completely and for the membrane to be clean, preferably sterile.

Currently sealed membrane units of this type are formed using a one-part (generally tubular) outer casing. The membrane fibres are threaded through the outer casing and the ends of the membrane are then fixed in place by adhesive. The adhesive is introduced into the outer casing and the whole unit is spun, so that the centrifugal forces created cause adhesive to locate at each end of the outer casing. The adhesive is then

allowed to set. However, this procedure is time consuming and the need to spin the units requires expensive machinery to ensure adequate results. Moreover, it cannot be guaranteed that an adequate seal will be produced at each end of the unit so that careful testing of each unit is required. In addition, the ends of the hollow fibre membranes frequently become blocked by adhesive during the spinning process.

The present invention lies in the recognition that a suitable unit may be formed using a much simpler methodology.

Thus, the present invention provides a process for forming a membrane unit wherein the outer casing is formed in two casing portions, a membrane is located within the casing and said casing portions are sealed together.

The present invention also provides a membrane unit wherein at least two outer casing portions are sealed together around a membrane. Generally the membrane unit will be produced by the process described above.

The membrane will normally be positioned or shaped to divide the internal volume of the outer casing into two discrete areas.

The seal between the membrane and the outer casing portions should be sufficiently tight so that communication between the two volumes described by the membrane only takes place by movement of material across the membrane itself. The seal between the outer casing portions should be sufficiently tight to prevent escape of the mother liquor or filtrate at the pressure at which the filtration is conducted.

In one embodiment a bundle of membrane fibres are cut roughly to length and are placed into a prepared mould. On closure of the mould the ends of the membrane bundle are held firmly. A quick-setting adhesive is injected into the mould close to each end of the membrane fibre bundle. The mould is formed so that the injected adhesive forms a plug of pre-determined size and/or shape close to each end of the membrane bundle. The adhesive is allowed to set. Preferably the adhesive is cured by exposure to UV light. Once the adhesive plugs have set, the membrane bundle is released from the mould. The exterior end of each plug is preferably trimmed, for example by use of a sharp knife or guillotine, which also slices through the membrane fibres ensuring that the exposed ends of each membrane fibres are free of cured adhesive. The membrane bundle is then placed into a pre-prepared outer casing portion. This casing portion, usually prepared by themoforming or casting is adapted so that a tight fit with the adhesive plugs are formed when the casing has been completed. The casing portions are adfixed together, optionally with adhesive, to form a sealed unit. Instead of using adhesive to complete the outer casing, the casing portions may be adapted to join together by a "snap fit" arrangement.

The above methodology of producing a plug around the membrane at a point where the membrane is to be held in the outer casing may also be used for a single hollow fibre membrane or for a sheet membrane. For sheet membranes the step of trimming the membrane and plug ends may be omitted since such membranes have no lumen to be blocked by adhesive.

In another embodiment the membrane is shaped as a flat sheet, rather than as a hollow fibre. In this

embodiment the flat sheet membrane(s) may be adhered directly to the outer casing portions, thus dividing the chamber bounded by the outer casing into two discrete volumes.

The adhesive used in the process of the present invention may be any adhesive material which does not react with the membrane or outer casing materials in a deleterious manner. Preferably the adhesive material is quick setting, ie cures within minutes, for example under 5 minutes. For certain embodiments adhesive material which cures upon exposure to light is particularly desirable. For example in medical applications it may be preferred to use adhesive which cures upon exposure to light, especially blue light or UV light.

Specific mention may be made of light or UV curable polymers available from Ablestick Ltd (for example LCM 32, LCM 34 and LCM 35), Bostick Ltd or Dynax Inc (especially 191M) as being useful in this regard.

The membrane for use in the device of the invention may be of any convenient shape and mention may be made of hollow membrane fibres and flat sheet or tubular membranes. Hollow membrane fibres or bundles of such fibres may be preferred in certain situations since this form permits a relatively large surface area through which filtration may occur. For other applications, however, flat membrane sheets (or bundles of such sheets) may be preferable. The membranes may contain pores of sizes from 0.001 to 30 microns in diameter or alternatively may possess Molecular Weight cut-off values from, for example 100 to 1,000,000 (eg 300 to 100,000, 500 to 1,000) Daltons.

The membrane may be made of any convenient material and the present invention is not limited to the membrane to be used. Generally the membrane will be selected for the filtration size. Ceramic filters, for example, may filter particles of diameter 5.0 μm to 0.1 μm and hollow fibre membranes may filter molecules of 1 mDa to 5 kDa. In Suitable membranes are available commercially and may be made of polysulphone, cellulose, cellulose diacetate, polypropylene, ceramics materials and/or other co-polymers.

Where the membrane is a ceramics material it is possible for the tight seal between the membrane and the outer casing to be formed by use of an "O" ring or the like formed of suitably resilient material, such as rubber or plastics.

As stated above the outer casing may be formed of any materials which may be shaped as desired. Generally therefore a castable or thermoformable material will be used. As examples, polycarbonate, polypropylene, PVC, high impact styrene, HDPE and acrylic materials may be mentioned.

Usually the outer casing portions will be shaped to allow a suitable amount of adhesive to be placed thereon. Thus, edges will normally have a lip where joining to another edge is required.

Optionally the outer casing portions are shaped to permit connections with inlet and outlet ports. Optionally additional inlet/outlet ports (for example two, three or four additional ports) are present to enable monitoring of the filtration process or for inserting a second fluid to control the pressure across the membrane.

Optionally connection tubes are located with the outer casing portions along with the membrane and a single adhesion step is used to seal the membrane and outer casing and also the inlet/outlet connection tubes. Likewise sensors can be located in position prior to sealing of the outer casing.

By way of example embodiments of the invention are shown in Figures 1-3.

Figure 1 shows general detail of the construction of the filter unit. Moulded casing halves 9 and 10 are sealed together with a UV-activated acrylic sealant to enclose a hollow fibre bundle membrane unit 11. The membrane unit 11 is bonded to the outer casing in such a way that a seal is formed at the ends of the whole filter cell.

Figure 2 shows a unit according to the present invention with outer casing portions 1, 2 and 2'. Upper outer casing portions 2 and 2' are alternatives allowing flexible manufacturing capacity. A membrane bundle 3 is illustrated with cured adhesive plugs 4, 5 at each end thereof. The plugs 4, 5 have been trimmed at their outer edges so that the end of each hollow membrane fibre is fully exposed. The adhesive plugs 4, 5 fit snugly into corresponding indentations 6 in the outer casing portions 1, 2, 2'. To seal the unit adhesive is smeared onto lip 7 of either or both upper and lower outer casing portions. Optionally indentations 6 may also receive adhesive. The membrane bundle 3 is located in the outer casing portions so that the plugs 4, 5 are both correctly located in indentations 6. The outer casing portions 1 and 2 (or 1 and 2' as appropriate) are then aligned and held together whilst the adhesive sets firmly. The unit is

shaped so that a tight seal around each plug 4, 5 is produced.

Inlet and outlet ports 8, 9 are also illustrated and optionally connectors may be adfixed thereto. Likewise side ports 10 are also shown; these enable sampling of the mother liquor during the process or addition of a second fluid to the mother liquor, for example to control the trans-membrane pressure. Alternatively the side ports may be used to hold a sensor which monitors the filtration process.

Figure 3 illustrates an alternative unit according to the present invention. This unit is formed as described for the unit of Figure 2 but the membrane bundle is bent into a "U"-shape to fit into the outer casing portions.

Claims

1. A membrane unit wherein at least two outer casing portions are sealed together around a membrane.

2. A membrane unit as claimed in Claim 1 wherein the membrane is a hollow fibre(s) membrane.

3. A membrane unit as claimed in Claim 1 wherein the membrane is a flat sheet membrane.

4. A membrane unit as claimed in any one of Claims 1 to 3 having at least one additional inlet/outlet port.

5. A process for forming a membrane unit wherein the outer casing is formed in two casing portions, a membrane is located within the casing and said casing portions are sealed together.

6. A process as claimed in Claim 5 wherein an adhesive plug is formed around the membrane.

7. A process as claimed in Claim 6 wherein the adhesive plug is formed from light curing adhesive.

8. A process as claimed in either one of Claims 6 and 7 wherein the ends of the set adhesive plugs are trimmed before insertion into the outer casing portions.

9. A process as claimed in any one of Claims 5 to 8 wherein the membrane comprises a hollow fibre membrane.

10. A process as claimed in any one of Claims 5 to 9 wherein the casing portions are sealed together and to the membrane using light curing adhesive.

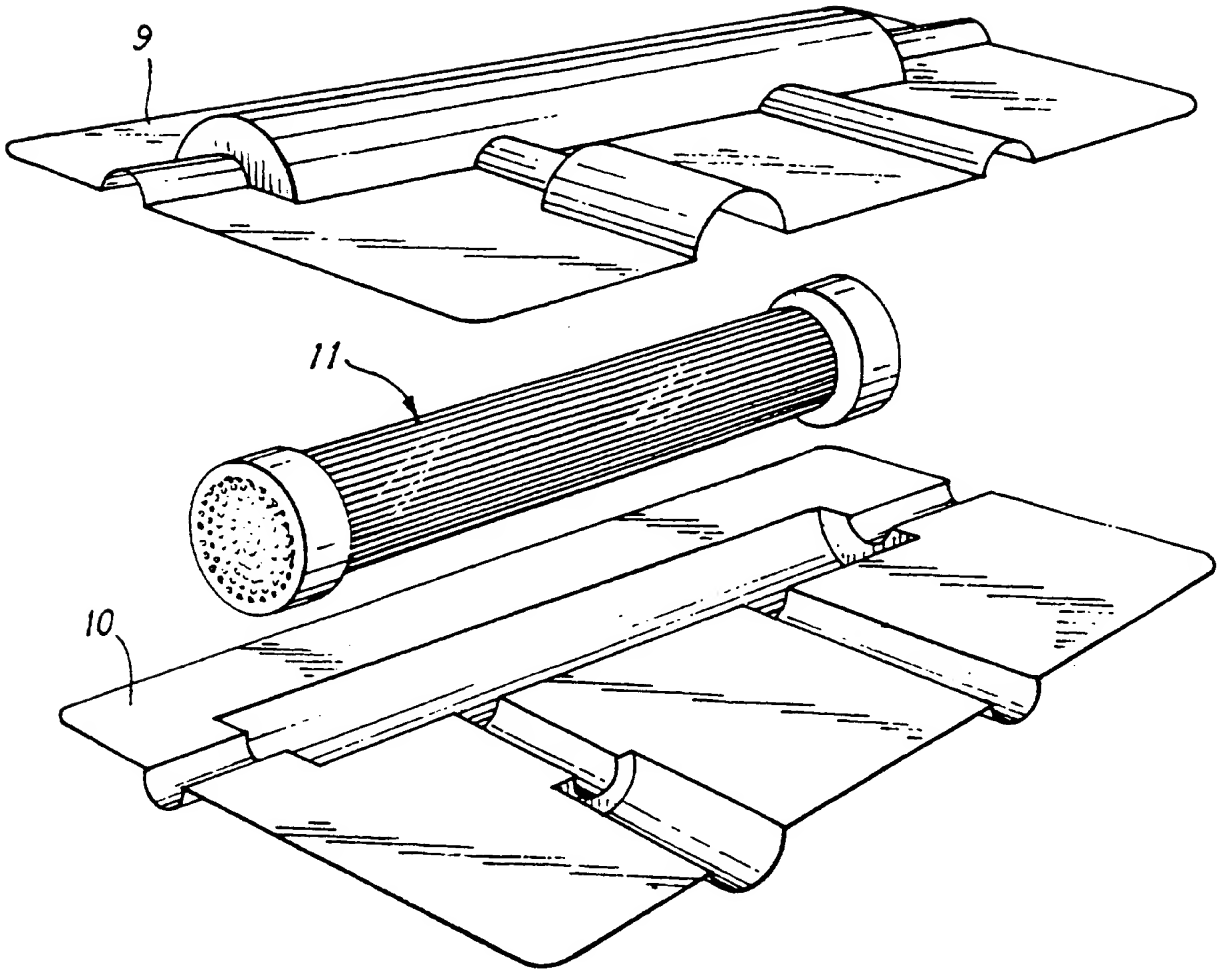

FIG.1

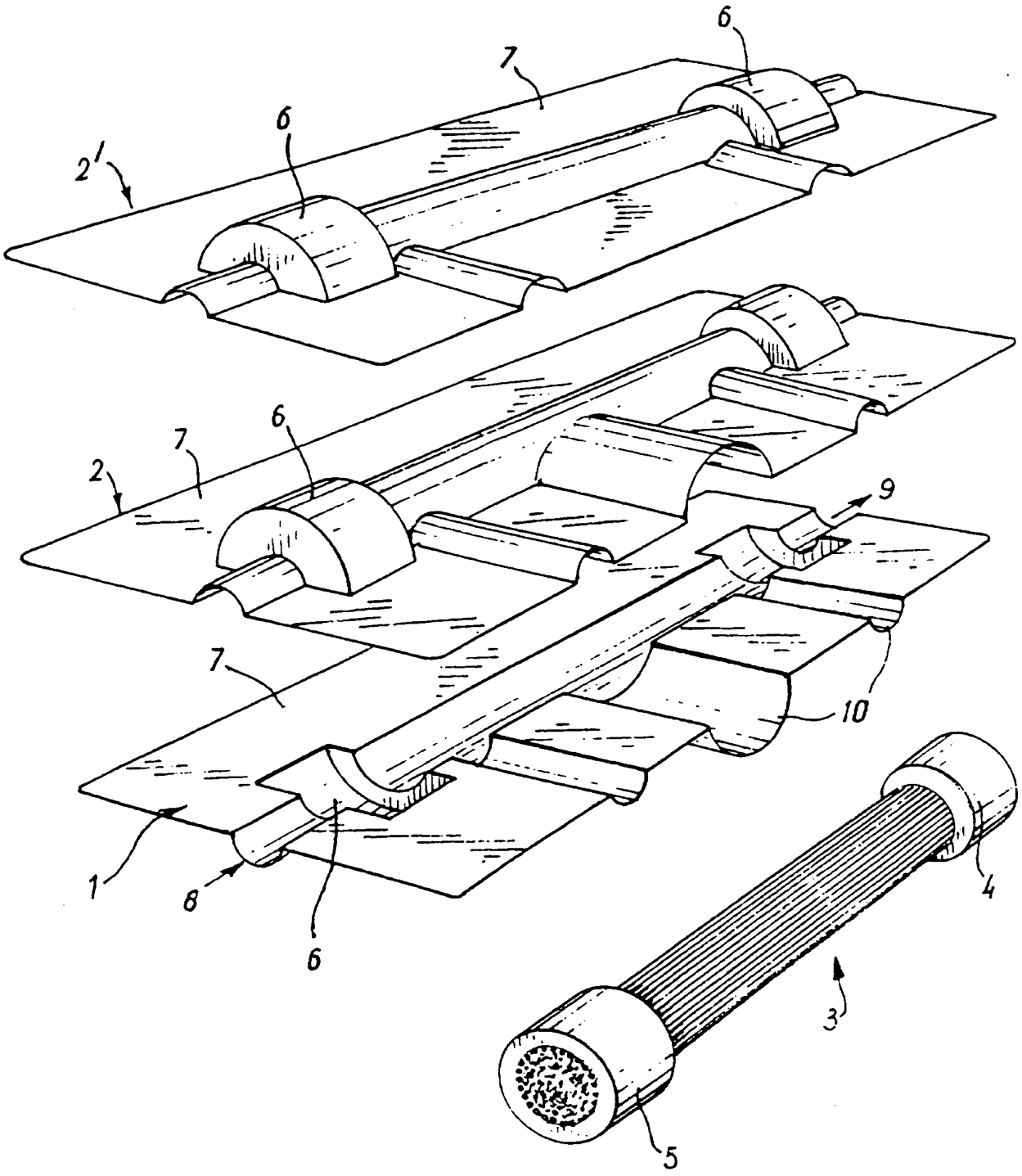

FIG 2

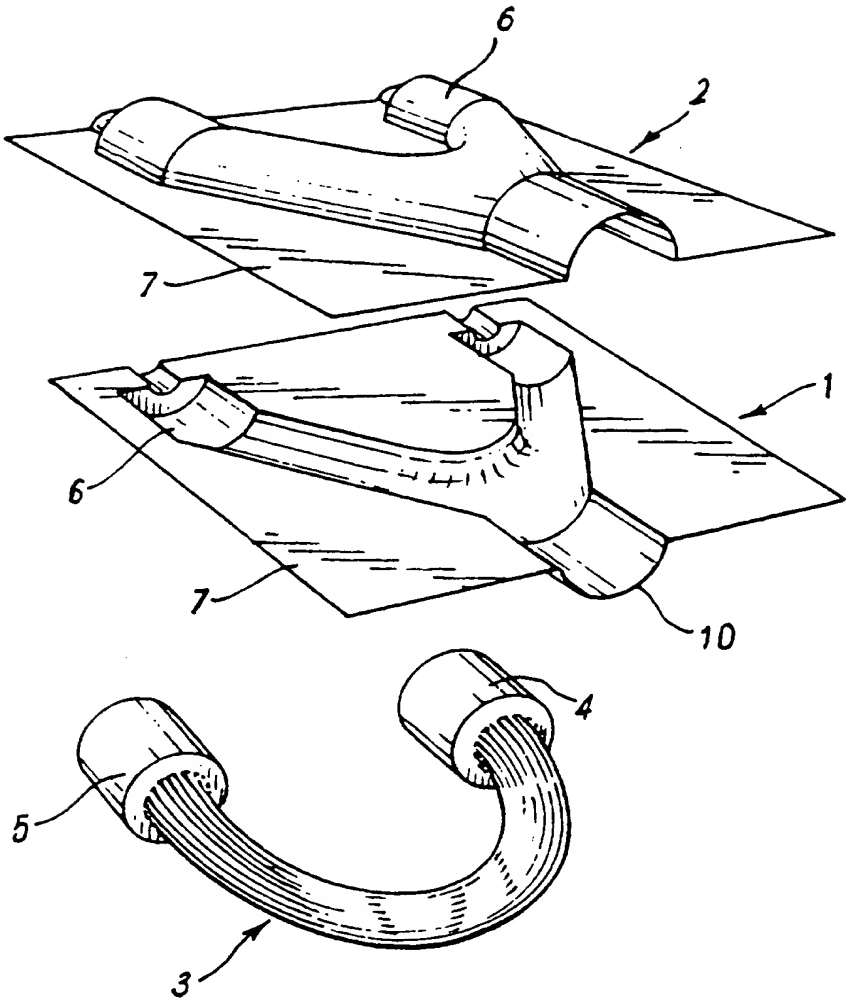

FIG. 3

INTERNATIONAL SEARCH REPORT

Inte ... lication No
PCT/GB 95/01836

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D65/00 B01D63/02 B01D63/08 B01D29/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 231 871 (B. J. LIPPS ET AL.) 4 November 1980 SEE ESPECIALLY COLUMN 12, LINES 9-29	1
A	AU,A,4 801 972 (THE DOW CHEMICAL CO.) 26 April 1974 SEE ESPECIALLY FRON PAGE 12, LINE 25, TO PAGE 13, LINE 11	1
A	EP,A,0 563 581 (MILLIPORE CORP.) 6 October 1993 see the whole document	1
A	US,A,5 011 555 (T. B. SAGER) 30 April 1991 see the whole document	1
A	EP,A,0 203 278 (AKZO GMBH) 3 December 1986 SEE ESPECIALLY FIGURES 3 AND 4	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Information on patent family members

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